

Fanning Island: Editor's Note

ATOLLS are unique features on the surface of the earth because they are essentially the products of living organisms and their activities; indeed, they have been called biological oases in the aquatic deserts of tropical and subtropical oceans. Despite their biological origin, however, physical and chemical factors such as winds, waves, water chemistry, and light combine to mold them and to sustain them. It is the continuing interaction of these processes, as well as their history, which has stimulated study of Fanning Island by two expeditions from the University of Hawaii,¹ the first in January 1970, the second in July and August 1972. Some of the results of the first expedition were published in *Pacific Science* in April 1971; several reports from the 1972 expedition are presented in this issue.

Fanning Island (3° 55' N, 159° 23' W) is a small (125 km²), roughly oval atoll lying midway in the string of shoals and atolls extending from 8° N latitude to 12° S latitude in the Line Islands. The major islands in the group are about 1,000 miles south, southeast, and northeast of Hawaii, Johnston Island, and the Phoenix Islands, respectively; 1,200 miles northwest of Tahiti, and 1,500 miles northwest of the Tuamotu Islands. The relatively small size of Fanning, its nearly complete encirclement by land, and its relatively undisturbed state contribute to its usefulness for study as a single system. Its geographical location, on the southerly and easterly fringe of the central Pacific faunal region of Ekman (1953), make it of special interest in biogeographical studies.

The biota of Fanning Island is principally of Indo-West-Pacific derivation, resembling that of the central Pacific rather than Hawaii. Peculiarities of species composition were suggested by Gosline (1971) and Kay (1971) as being due to ecological conditions of islands rather than open water distances between them. Maragos (1974a—this issue) indicates that the

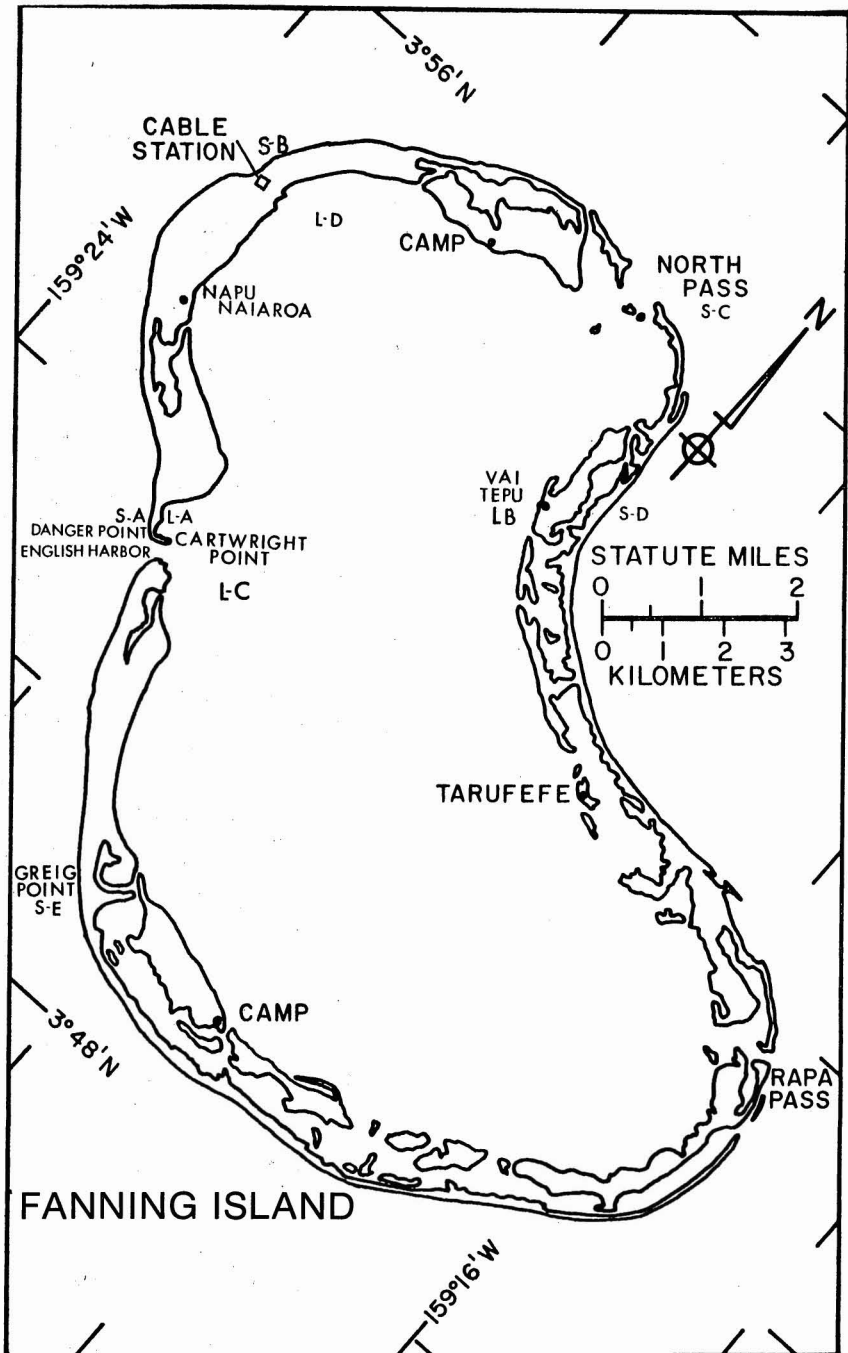
coral fauna is far richer than might have been expected in the area. Townsley and Townsley (1973) report densities of the echinoderm fauna as being greater than those reported elsewhere.

The ocean water surrounding Fanning Island is of nearly constant composition, with salinities of about 35 ‰, suspended calcium carbonate load of less than 0.03 mg/liter (Smith et al. 1971), and concentrations of total and particulate carbon of about 1.2 mg/liter and 32 µg/liter respectively (Gordon 1971). During much of the year Fanning lies in the southeasterly trade-winds, which blow across the lagoon at mean speeds of 10 knots from 135°. The tradewinds and surf from the southeast have molded the windward reefs into rather narrow structures margined only occasionally by a spur and groove system. Fields of broken coral and rubble, and the absence of reef corals on the upper slopes, suggest that wave action is a significant factor in the development of the windward reefs (Maragos 1974a—this issue). The leeward ocean reef slopes in contrast are wider, more fully developed, and harbor the greatest diversity and abundance of corals on the atoll (Maragos 1974a—this issue). Corals dominate the reef slopes to depths of 36 m and both corals and fish show pronounced vertical zonation (Maragos 1974b—this issue; Chave and Eckert, this issue).

The reefs and islets comprising the atoll almost completely encircle the lagoon. The reefs are breached only in one place by a deep pass (ca. 8 m) on the west (English Harbor), through which 90 percent of the water exchange between lagoon and ocean occurs. Two shallow passes (or interisland reef flats), North Pass and Rapa Pass, the latter on the southeast, separate the islets.

Inside the lagoon conditions are quite different from those of the seaward aspect of the atoll: lagoon water varies widely in composition, salinity, alkalinity, and pH (Gordon and Schiesser 1970; Smith and Pesret, this issue); calcium carbonate concentrations vary from 1 mg CaCO₃/liter in clearwater sectors to 4 mg CaCO₃/liter in turbid water areas (Smith

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et al. 1971); concentrations of organic carbon are higher in the lagoon than without; and the composition of the biota is distinct from that of the seaward reef flats and slopes.

The most unusual features of Fanning Lagoon are its turbidity and high productivity, the latter estimated in 1970 as perhaps an order of magnitude greater than that reported for other atolls (Gordon and Schiesser 1970). Smith and Pesret (this issue), using CO_2 as a tracer, find net organic carbon transfer in the lagoon is near zero, and suggest a close balance between production and consumption. Biological calcification accounts for most or all of the CaCO_3 precipitated in the lagoon; but calcification rates of about $1 \text{ kg CaCO}_3 \text{ m}^{-2} \text{ year}^{-1}$ are lower than those estimated from standing crop and growth rate of corals (Smith and Pesret, this issue).

The high calcium carbonate load of lagoon waters and its consequent turbidity affect both topography and the distribution of organisms within the lagoon. In turbid water sectors ribbonlike reefs form networks across the sandy floor, enclosing a series of ponds or basins (Roy and Smith 1971). The dominant corals of these reefs are ramose *Acropora* and *Stylophora* (Maragos 1974a—this issue). In the clearwater sectors massive corals such as *Porites* predominate. The distribution of fishes, mollusks, echinoderms, and algae is clearly associated with variations in turbidity and salinity and the types of reefs (Chave and Eckert, this issue; Kay, this issue; Townsley and Townsley 1973; Russell 1973; Tsuda 1973).

The characteristics of the lagoon are determined not only by the amount and rate of water exchange between the ocean and lagoon, rainfall, and evaporation, but also by the landmass of the atoll from which nutrients and ground-water leach into the lagoon. Surrounding the lagoon are three islets, vegetated by coconut trees which provide raw materials for the copra industry employing approximately 600 Gilbertese natives. *Pisonia* forest occurs where phosphate rock forms the substratum. *Pandanus*, including a new species and a new cultivar described by St. John (this issue), is a dominant plant on the atoll, as are *Messerschmidia* and *Scaevola*. Among the terrestrial animals, crustaceans replace fossorial insects, annelids, and vertebrates of continents and volcanic islands

as soil mixers; the land crab *Cardisoma* alone may turn over as much as $9.53 \text{ m}^3/\text{ha}/\text{yr}$ of soil (Fellows 1973).

The landward portions of the atoll are also important in determining lagoon characteristics because of brackish-water flats or ponds which dissect the islands of the atoll. Along the lagoon shore, inlets increase the area of the island margin and focus fresh or brackish discharges at specific points along the lagoon margin (Guinther 1971; this issue). The inlets are not only regions where terrestrial and marine environments meet, but are also significant in providing in an otherwise homogeneous environment regions where there are extreme fluctuations in salinity and temperature and hence habitats for euryhaline biota (Guinther, this issue).

The structure of the atoll, distribution of land around the rim, the patterns of distribution of the line and patch reefs in the lagoon, the extensive development of brackish-water ponds, and the occurrence of phosphate rock all suggest a complicated history of atoll formation and development. To explain some of the observations of the 1970 expedition, it was suggested that the atoll is tilting toward the west, and that a post-Pleistocene shift in the meteorological equator and in the equatorial current system has occurred (Roy and Smith 1971). Events and observations during the 1972 expedition suggest that, in addition to long-range processes, abrupt and perhaps even catastrophic events are also significant in atoll development. The rubble fields and structure of the seaward reefs, as well as shingle berms of seaward sections of the islets, indicate a significant role of severe wave action in forming the atoll (Maragos 1974a—this issue; Gallagher 1970). Accumulations of dead mollusk shells may have been caused by abrupt changes in salinity and/or turbidity (Kay, this issue). That extreme changes in salinity do occur was given ample evidence during the 8-week visit of the second expedition when a mean rainfall of 1.5 cm/day was recorded in July and August. This extensive rainfall, associated with instability of the Intertropical Convergence Zone in 1972, effectively raised the Ghyben-Herzberg lens of the landward parts of the atoll, flooding low ground (Guinther, this issue), and shifted lagoon salinities from

near seawater salinities recorded in 1970 to less than 32 ‰ in 1972 (Smith and Pesret, this issue).

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